Greetings and welcome to the **FEBRUARY 2015** edition of the WDFW Climate News Digest. Our purpose is to provide highlights of relevant climate change news, events and resources for WDFW staff. Feedback or suggestions for items to include in future editions are much appreciated – many *thanks* to those who have sent links and references and please keep them coming. Note that previous editions of the newsletter are now stored on the Habitat Program Sharepoint site and on the agency's climate change web page.

Thanks for contributions this month from William Meyer, Brian MacDonald, Jen Vanderhoof (King County), Andy Weiss, Wendy Connally, Joe Buchanan, Josh Halofsky (DNR)and Dan Isaak (USFS)

WHAT'S HAPPENING AT WDFW?

WDFW Beaver restoration projects enhance Watershed function and promote climate resilience
William Meyer (Habitat Program) leads the Yakima Basin Beaver Reintroduction Project, with a goal of enhancing watershed function by relocating "problem beavers" to the upper Yakima River tributaries. Loss of beaver has been cited as a limiting factor in numerous salmon, steelhead, and watershed recovery plans, and has been discussed as a way to promote resilience of natural systems to climate change. Over the four years of the project 130 beavers have been removed from urban and agricultural areas in the lower Yakima Basin, where they are currently being lethally removed and relocated to 44 headwater sites. Successful establishment is measured after one year of occupancy and has been averaging 35-40%, with the 2014 translocations to be measured in the 2015 season. Groundwater storage has been estimated at approximately 1 million gallons per colony per year, utilizing methods described by Pollock et. al. 2003. William hopes to continue the project for an additional 5 years, in order to increase our understanding of the watershed benefits, if funding can be secured. He encourages all to pass along any appropriate funding opportunities. In his words, "each year we learn many new things!" For more, please contact William Meyer.

WDFW and its partners in the project, notably Melissa Babik at Mid-Columbia Regional Fisheries Enhancement Group, have gotten some great press over the years – for more take a look at these articles.

- http://www.npr.org/2014/10/11/355340426/researchers-say-beavers-are-more-than-simple-pests
- http://seattletimes.com/html/localnews/2024723503_beaversrestorationxml.html
- http://www.cbc.ca/asithappens/features/2014/10/08/moving-beavers/

Also of note: the recent **Report of the Climate Change Adaptation and Beaver Management Team to the Working Group Implementing the *National Fish, Wildlife, and PlantClimate Change Adaptation Strategy*.** The Team was charged with reviewing reasonably available information and making recommendations concerning the potential for changes in beaver management practices to promote resilience of natural systems to climate change.

CLIMATE ADAPTATION AT OTHER ORGANIZATIONS

Federal Highway Administration Case Studies (including WSDOT)
FHWA selected five teams from across the country to test a climate change vulnerability assessment model, and used the feedback and lessons learned to revise the draft conceptual model into the Climate Change & Extreme Weather Vulnerability Assessment Framework. Case studies and other resources are available on **Hampton Roads, VA**, **Oahu, HI**, **San Francisco, CA**, **North Jersey**, and **Washington State**

Community Coastal Resilience in Practice
The Nature Conservancy's Coastal Resilience process has been applied in different geographies around the world. This month, two examples from the cities of **Guilford** and **Bridgeport** in Connecticut demonstrate how community-driven efforts to address climate change and extreme events are improving resilience and reducing vulnerability of ecosystems and infrastructure.

LEARNING OPPORTUNITIES

February 12, 10:00-11:00 (Pacific), *Webinar* – **OneNOAA Science Seminar - Weather-Climate Linkages: Analysis, Modeling, and Prediction Efforts**

February 12, 10:00-11:00 (Pacific), *Webinar,* National Adaptation Forum Webinar Series: Ensuring Social Equity in Preparing for Climate Change: Challenges and Solutions

February 25, 11:00-12:00 (Pacific), *Webinar,* Application of the Sea Level Affecting Marshes Model (SLAMM) to New York and Connecticut

March 4: 10:00-11:00 (Pacific), *Webinar*. Estimating Blue Carbon Storage in Texas Coastal Wetlands

RESOURCES

Office of Washington State Climatologist
The February edition of the Office of Washington OWSC newsletter is attached to this email and also available online at: http://www.climate.washington.edu/newsletter/. Topics include: January climate summary, 2014 in review, Snowpack update, Temperature and precipitation outlook.

Check Out the USDA Climate Hubs National Website and Informational Video
The national website for the network of U.S. Department of Agriculture Climate Hubs is now up and running! A video has also been developed describing the purposes of the new Climate Hubs. Check out the Website and Video.

NOAA National Sea Grant Resilience Toolkit Released
Sea Grant recently launched the National Sea Grant Resilience Toolkit - a compilation of tools and resources to help local communities become more resilient. Each entry includes a description of the tools, a link for more information, and a point of contact. The toolkit combines more than 100 tools and will be updated as more tools are created. To access the toolkit, visit: http://seagrant.noaa.gov/WhatWeDo/ResilienceToolkit.aspx.

The Scenario-Based Projected Changes Map
This online map provides access to localized scenarios of projected changes in annual total precipitation, precipitation intensity, annual average temperature, 100-year storm events, and sea-level rise from EPA's Climate Resilience Evaluation and Awareness Tool. To explore local climate change projection data across the United States, simply zoom in on a location of interest or type a location into the search field of the map. Climate change projection data within this map is provided by grid cell, illustrated as a square grid with 1/2-degree resolution, approximately 32 x 32 miles, for the United States. Explore the map at: http://water.epa.gov/infrastructure/watersecurity/climate/scenario.cfm.

NOAA Fisheries releases draft Climate Science Strategy for public comment

The strategy identifies 7 steps to increase the production and use of climate-related information; proposes actions to address common needs across regions and agency mandates; and aims to help reduce impacts and increase resilience of marine resources and the communities that depend on them.

Key Concepts in Climate Change Adaptation

The World Wildlife Fund has developed a Climate-Smart Conservation learning resource, WWFAdapt, aimed at conservation practitioners. Five quick (2-9 minute) modules take the learner through key concepts and terminology needed for applying climate-smart conservation principles

Climate data initiative releases ecosystem vulnerability and water resources resilience themes

The Obama Administration released two datasets as part of the Climate Data Initiative. The datasets focus on "Ecosystem Vulnerability" and "Water." Data from the Ecosystem Vulnerability hub can be used to further understand the climate change impacts on water resources, biodiversity, invasive species, the ability of our ecosystems to sequester carbon, and the frequency and extent of wildland fires. Data from the water resources resilience theme provides information that can help communities and governments develop plans and policies to ensure the provisioning of water resources in the face of climate change. For more information visit: http://www.data.gov/climate/

CLIMATE SCIENCE NEWS

Global Climate Modeling --New Accounting Method For Sources of Uncertainty

Climate scientists use global climate models to understand the range of possible futures. Dozens of research groups produce hundreds of simulations, which may differ in their greenhouse-gas emission scenarios as well as their starting conditions for each simulation. Thus, interpretation can be challenging. Now, researchers Paul Northrop and Richard Chandler of the University College of London address this problem by offering a consistent framework that includes all available simulations and sorts out the role for each source of difference: emissions scenario, choice of climate model, and initial conditions. The researchers found that variability is linked more strongly to the choice of global climate model than to different emissions scenarios earlier in the current century (2020-49). But scenario variations dominate later in the century (2069-89). They also found that variations across runs for the same model are important early in the century, but variations across runs are not important late in the century, nor in the global mean. For precipitation changes in western North America, they found that variations across runs are the most important factor earlier in the century, followed closely by scenarios. Toward the end of the century, this order reverses, but variations across runs are still important.

Northrop, P.L. & R.E. Chandler (2014) Quantifying Sources of Uncertainty in Projections of Future Climate. *J. Climate*, **27**, 8793–8808. doi: http://dx.doi.org/10.1175/JCLI-D-14-00265.1

Melting Glaciers Will Impact the Flow of Organic Carbon to Downstream Ecosystems

According to a new study, the impact from melting glaciers due to climate change will be more complex than just causing changes to global sea-levels. Melting glaciers will potentially have a major impact on the flow of organic carbon to oceans around the world. Learn More >>

Washington Stream Thermal-scape *(from Dan Isaak, USFS)*

The temperature database and climate scenarios for all 66,236 stream kilometers in the state of Washington are now available on the NorWeST website. The data to develop the stream scenarios were collected by hundreds of individuals and contributed by more than 35 state, tribal, federal, county,

municipal, and private resource organizations. A detailed map showing the stream thermalscape for Washington is attached to this email, and can also be viewed dynamically online in this GoogleMap tool: http://www.sciencebase.gov/flexviewer/NorWeST/ (zoom in until the streams appear). For more information visit the NorWest website.
Note: for those at WDFW with GIS capabilities, Brian Cosentino and Andy Weiss have made the dataset available here: I:\programs\wildlife\gis\WA_StreamTempClimate.

Sea Change, the Pacific's Perilous Turn
An excellent series by Craig Welch of the Seattle Times explores the "lesser known twin of climate change", ocean acidification, and its impact on marine life and food webs.
http://apps.seattletimes.com/reports/sea-change/2013/sep/11/pacific-ocean-perilous-turn-overview/?prmid=4749

SPECIES AND HABITATS

Climate change and land management in the rangelands of central Oregon, Creutzburg et al (attached)
Excerpt from the abstract, " Climate change, along with exotic species, disturbances, and land use change, will likely have major impacts on sagebrush steppe ecosystems in the western U.S. over the next century. To effectively manage sagebrush steppe landscapes for long-term goals, managers need information about the interacting impacts of climatechange, disturbances and land management on vegetation condition. This project evaluated the potential impacts of climate change on rangeland condition in central Oregon and the effectiveness of multiple management strategies. Under three scenarios of climate change, we projected widespread shifts in potential vegetation types over the twenty-first century, with declining sagebrush steppe and expanding salt desert shrub likely by the end of the century. Our approach allows researchers and managers to examine long-term trends and uncertainty in rangeland vegetation condition and test the effectiveness of alternative management actions under projected climate change."

Tracking U.S marine fish populations as climate changes
Developed by NOAA Fisheries and Rutgers University, OCEANADAPT is a web tool designed to provide distribution data on nearly 650 species of U.S fish and invertebrates important for commercial and recreational fishing. Marine fish and vertebrate populations are responding to changing ocean conditions by shifting their distributions northward to cooler waters. OCEANADAPT is a valuable tool for fishermen, managers, scientists, and fishing communities tracking and evaluating the distribution of marine fish and other species with changing climate and ocean conditions.

What do managers need to know about warming rivers?
The attached article from researchers in the United Kingdom discusses how gaps in our understanding of changes in river flow and water temperature may limit the effectiveness of some mitigation measures. These knowledge gaps include where to target measures, how to implement in different situations, how to maximize co-benefits and integrate with other policy objectives, and how to support implementation across rural and agricultural landscapes. The article concludes that despite many uncertainties, restoration of riparian shade and river flows has the potential to deliver multiple benefits even if this does not include retarding rates of warming.

Ocean acidification threatening shellfish hatcheries
A recent study published in *Nature Climate Change* has found that the Pacific oyster and Mediterranean mussel larvae are sensitive to saturation state, and not carbon dioxide partial pressure or pH. Saturation

state is a measure of how corrosive seawater is to calcium carbonate shells of calcifying organisms. Successful larval development and growth during shell formation is heavily dependent on seawater saturation state. While pH levels affect other physiological processes, the saturation state threshold will be crossed decades earlier than pH thresholds, due to the nonlinear responses of saturation state as atmospheric CO_2 concentrations are increased. This study adds to the body of evidence suggesting that moderate ocean acidification impacts almost caused the complete collapse of the PNW oyster industry.

Pacific salmon challenged by warming waters

This paper investigates the ability of Chinook salmon to adapt to warming water temperatures caused by climate change. The researchers found that the salmon developed cardiac irregularities in waters warmer than 24.5°C. Based on an average warming projection, researchers predict a 17% chance of "catastrophic" loss in the population by 2100, with this chance increasing to 98% in a maximum warming scenario. A constraint on the upper limit of thermal tolerance highlights the susceptibility of Pacific salmon populations to projected increases in temperature.

Research explores the effect of model uncertainties on ranking conservation risks under climate change

This new paper describes findings from an evaluation of how metrics used to rank species by conservation risk responds to "the choice of global climate models, greenhouse gas emission scenarios, suitable versus unsuitable threshold values, and the degree of model complexity". Find the Paper (Wright et al. 2014) Here >>

Bioinvasions in a changing world

The Aquatic Nuisance Species Task Force (ANSTF) and The National Invasive Species Council (NISC) have released a new document: *Bioinvasions in a Changing World: A Resource on Invasive Species-Climate Change Interactions for Conservation and Natural Resource Management*
Download the document HERE Or visit invasivespecies.gov for more information on the National Invasive Species Council.

One bird becomes a sentinel for global warming

From the Daily Climate
The Arctic is home to a small black-and-white tuxedoed bird that can fly as well as swim, and the little auk, also known as the dovekie, is serving as sentinel of global warming. Marked sea-ice retreat has profoundly altered the feeding habits of little auks in Russia's Franz-Josef Land, an archipelago that is their northernmost breeding ground, a research team reported in *Global Change Biology*. Using miniature electronic tags, the scientists showed that the smallest of the European auks, members of the puffin family, were losing their main prey, lipid-rich zooplankton. The birds adapted by shifting to new foraging spots at the front of melting glaciers, where zooplankton become stunned by cold and osmotic shock. Little auk chick growth rates thus stayed steady, but adult body mass fell 4 percent compared to 21 years ago – a potential problem for a bird about the size of a quail.

Warming climate likely will change the composition of northern forests

(from Science Daily)
A new study used a unique long-term outdoor experiment to examine the effects of climate change on trees in the boreal forest along the U.S.-Canadian border. The study, published in the journal *Nature Climate Change*, notes that species like spruce and fir that thrive in cooler areas to the north in Canada suffered poorer growth and survival when warmed by a few degrees, while trees like oaks and maples that prefer a more temperate climate performed better when warmed. Other species like aspen, birch, and pine, had a more neutral response. While all of these species may continue to co-exist, at least for a time, in

a warmer climate, the study found that the balance of power, competitively speaking, shifted from the boreal species to the oaks and maples.
Peter B. Reich et al, Geographic range predicts photosynthetic and growth response to warming in co-occurring tree species. *Nature Climate Change*, 2015; DOI: 10.1038/nclimate2497

Seeing the climate through the trees: observing climate and forestry impacts on streamflow using a 60-year record, Burt et al. (attached)
Excerpt from the abstract
New understanding of climate variability provides an opportunity to examine whether climate variability interacts with forestry treatments, in a predictable manner. Here, we use data from the H. J. Andrews Experimental Forest, Oregon, USA, to examine the impact of the El Niño-Southern Oscillation on streamflow linked to forest harvesting. Our results show that the contrast between El Niño and La Niña events is so large that, whatever the state of the treated watershed in terms of regrowth of the forest canopy, extreme climatic variability related to El Niño-Southern Oscillation remains the more dominant driver of streamflow response at this location. Improvements in forecasting interannual variation in climate might be used to minimize the impact of forestry treatments on streamflow.

Spatially heterogeneous impact of climate change on small mammals of montane California, Rowe et al (attached)
Excerpt from the abstract
Here we repeated early twentieth century surveys of small mammals along elevational gradients in northern, central and southern regions of montane California. Of the 34 species we analysed, 25 shifted their ranges upslope or downslope in at least one region. However, two-thirds of ranges in the three regions remained stable at one or both elevational limits and none of the 22 species found in all three regions shifted both their upper and lower limits in the same direction in all regions. When shifts occurred, high-elevation species typically contracted their lower limits upslope, whereas low-elevation species had heterogeneous responses. For high-elevation species, site-specific change in temperature better predicted the direction of shifts than change in precipitation, whereas the direction of shifts by low-elevation species was unpredictable by temperature or precipitation. While our results support previous findings of primarily upslope shifts in montane species, they also highlight the degree to which the responses of individual species vary across geographically replicated landscapes.

POLICY AND MANAGEMENT - MITIGATION AND ADAPTATION

Obama orders federal agencies to account for flooding from climate change in investments
President Obama signed an executive order directing federal agencies to adopt new flood elevation standards for the siting, design, and construction of federal projects.
The new rules will ensure that flooding from climate change will be taken into account in the development of federal projects and are expected to save taxpayers money in the long run by reducing federal disaster assistance spending following extreme weather events. The new standard gives agencies three options for establishing the flood elevation and hazard area used in siting, design, and construction:
1. Use data and methods informed by best-available, actionable climate science;
2. Build two feet above the 100-year flood elevation for standard projects, and three feet above for critical buildings like hospitals and evacuation centers; or
3. Build to the 500-year flood elevation.

Click here for more from the New York Times.

Survey finds doctors concerned about impacts of climate change on patient health

A survey of members of the American Thoracic Society, which represents 15,000 physicians and other medical professionals who work in the fields of respiratory disease, critical care and sleep disorder, finds that the majority of respondents said they were already seeing health effects in their patients that they believe are linked to climate change. Seventy-seven percent said they have seen an increase in chronic diseases related to air pollution, and 58 percent said they'd seen increased allergic reactions from plants or mold. Fifty-seven percent of participants said they'd also seen injuries related to severe weather. An overwhelming majority -- 89 percent -- agreed that climate change is happening, and 65 percent said they thought climate change was relevant to direct patient care.

Could the global economic tide be starting to turn against fossil fuels?

A contributing writer to *Yale Environment 360*, Fred Pearce, addresses a question that once might have been considered unthinkable. Citing a host of recent developments — from a U.S.-China agreement to cut CO2 emissions to a steady move away from burning coal — Pearce says a growing number of economists and analysts believe the shift away from fossil fuels could be reaching a turning point. With oil prices plunging, mainstream economists are even beginning to discuss the prospect of "stranded" fossil fuel assets. As one environmentalist tells Pearce, "I now think this is how the carbon war can be won." Read Pearce's analysis.

Most Republicans say they back climate action, poll finds

An overwhelming majority of the American public, including half of Republicans, support government action to curb global warming, according to a poll conducted by The New York Times, Stanford University and the nonpartisan environmental research group Resources for the Future.